



Original Contribution

ED crowding and the use of nontraditional beds[☆]

Candace McNaughton MD^{a,b,*}, Wesley H. Self MD, MPH^a,
Ian D. Jones MD^a, Patrick G. Arbogast PhD^c, Ning Chen MS^c,
Robert S. Dittus MD, MPH^{b,d}, Stephan Russ MD, MPH^a

^aDepartment of Emergency Medicine, Vanderbilt University, Nashville, TN 37232, USA

^bTennessee Valley Geriatric Research, Education and Clinical Center, Department of Veterans Affairs, Nashville, TN 37232, USA

^cDepartment of Biostatistics, Vanderbilt University, Nashville, TN 37233, USA

^dDepartment of Medicine, Vanderbilt University, Nashville, TN 37233, USA

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Abstract

Background and Objectives: In an effort to compensate for crowding, many emergency departments (EDs) evaluate and treat patients in nontraditional settings such as gurneys in hallways and conference rooms. The impact of this practice on ED evaluation time is unknown.

Research Design and Subjects: A historical cohort of adult ED visits to an academic hospital between August 1, 2009 and August 1, 2010, was used to evaluate the relationship between ED bed assignment (traditional, hallway, or conference room bed) and mean ED evaluation time, defined as the time spent in an ED bed before admission or discharge. Chief complaints were categorized into the 5 most frequent categories: abdominal/genitourinary, joint/muscle, general (fever, malaise), head/neck, and other. Multiple linear regression and marginal prediction were used to calculate the mean ED evaluation times for each bed type, overall, and by chief complaint category.

Results: During the study period, 15 073 patient visits met the inclusion criteria. After adjustment for patient and ED factors, assignments to hallway and conference room beds were associated with increases in a mean ED evaluation time of 13.3 minutes (95% confidence interval, 13.2–13.3) and 10.9 minutes (95% confidence interval, 10.8–10.9), respectively, compared with the traditional bed ED evaluation time. This varied by chief complaint category.

Conclusions: Use of nontraditional beds is associated with increases in mean ED evaluation time; however, these increases are small and may be further minimized by restricting the use of nontraditional beds to patients with specific chief complaints. Nontraditional beds may have a role in improving ED throughput during times of crowding.

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* Corresponding author. Tel.: +1 615 936 0087; fax: +1 615 936 1313.

E-mail addresses: candace.mcnaughton@vanderbilt.edu (C. McNaughton), wesley.self@vanderbilt.edu (W.H. Self), ian.jones@vanderbilt.edu (I.D. Jones), patrick.arbogast@vanderbilt.edu (P.G. Arbogast), ning.chen@vanderbilt.edu (N. Chen), robert.dittus@vanderbilt.edu (R.S. Dittus), stephan.russ@vanderbilt.edu (S. Russ).

1. Introduction

Emergency department (ED) beds are a scarce resource [1–4]. Patient visits to EDs continue to increase, whereas the number of beds available to accommodate them shrinks. Emergency department crowding is a worldwide problem that is expected to worsen over time [5]. Boarding of admitted patients in the ED has been recognized as one of the drivers of ED crowding [2,4,6,7], in part, because it effectively reduces the number of ED beds available for evaluating and treating new patients. ED boarding and crowding are associated with treatment delays [8,9], lower quality care [10], increased risk of medical error [11], increased hospital length of stay [12], increased numbers of patients leaving without being seen [13], and decreased patient satisfaction [2].

In an effort to maintain patient flow despite crowding and boarding, many EDs have developed innovative alternatives to traditional ED treatment rooms [14], including physicians treating patients in the waiting room [15] and using gurneys located in hallways and conference rooms as patient evaluation areas. The number of EDs using nontraditional patient evaluation areas such as hallways and conference rooms is not reported, but anecdotally this practice has become commonplace [7]. Previous research, much of it done in Norway, has focused on patient satisfaction [16,17] and the use of hallway beds located on inpatient wards [18–23]. However, to our knowledge, no studies have addressed the relationship between nontraditional bed use and ED throughput. Patients assigned to nontraditional beds may be considered lower priority than patients assigned to traditional beds, leading to delays in their care. In addition, because nontraditional beds are often unplanned additions to ED facilities, supplies needed for patient care may be difficult to locate. Obtaining sensitive information, such as social and sexual history, and performing pelvic and rectal examinations are logistically difficult when patients are located in nontraditional beds. Given the concern that patients assigned to nontraditional beds may experience delays in care, the primary aim of this study was to evaluate the relationship between bed type (traditional bed, hallway bed, or conference room bed) and ED evaluation time, defined as the length of time patients spent in an ED bed before admission or discharge. The secondary aim was to evaluate the relationship between bed type and ED evaluation time stratified by chief complaint category.

2. Research design and methods

We conducted a historical cohort study using data extracted from an integrated ED information system in an urban, academic adult ED with an annual volume of approximately 55 000 patients. An electronic tracking

board [24], computerized provider order-entry system [25], and electronic medical record [26] were used to track every electronic encounter that occurred in patients' medical records throughout their ED and hospital course. All data were obtained by an electronic query of the existing administrative data.

The study period was August 1, 2009 through August 1, 2010. Hallway and conference room beds were routinely staffed during weekdays (Monday–Friday 11 AM to 11 PM) when more than 90% of the traditional beds were occupied. We included patient visits in which disposition was determined after the patient was assigned to a traditional ED bed or to a ED hallway or conference room bed (ie, the patient was not treated, admitted, and discharged while still in the waiting room) and in which in the first physician orders occurred after bed assignment (initiating orders for patients in the waiting room has already been shown to significantly decrease ED evaluation time) [34].

Patient visits were excluded if any of the following occurred (Fig. 1):

- The patient left against medical advice.
- The patient was transferred to another hospital or to a psychiatric facility.
- The patient was younger than 18 years; standard practice at this institution involved transferring pediatric patients to a separate pediatric ED located within the same medical center before physician evaluation.
- Registration errors occurred, making the time stamps unreliable.
- The patient was suspected of having acute coronary syndrome. By departmental policy, patients with suspected acute coronary syndrome were not placed in a hallway or conference room bed.

The exposure of interest was *ED bed assignment*: traditional ED bed, hallway ED bed, or conference room ED bed. Patients checking into the ED or arriving by ground emergency medical services were assigned to an ED bed by a triage physician [15] or nurse. There was no explicit protocol to guide bed assignment, although moving patients out of the waiting room and into a treatment area, regardless of bed type, was the priority. Patients assigned to a traditional bed were not moved into a nontraditional bed; that is, patients did not flow “back” into nontraditional beds once they were assigned a traditional bed. The study hospital did not have a fast-track area to divert low-acuity patients; instead, the triage physician treated and released approximately 1 patient with a low-acuity complaint per hour from the waiting room.

The ED included 46 traditional beds, 7 hallway beds, and 5 conference room beds. Traditional beds were located within separate ED treatment rooms, which contained standard ED bedside supplies organized to maximize efficiency.

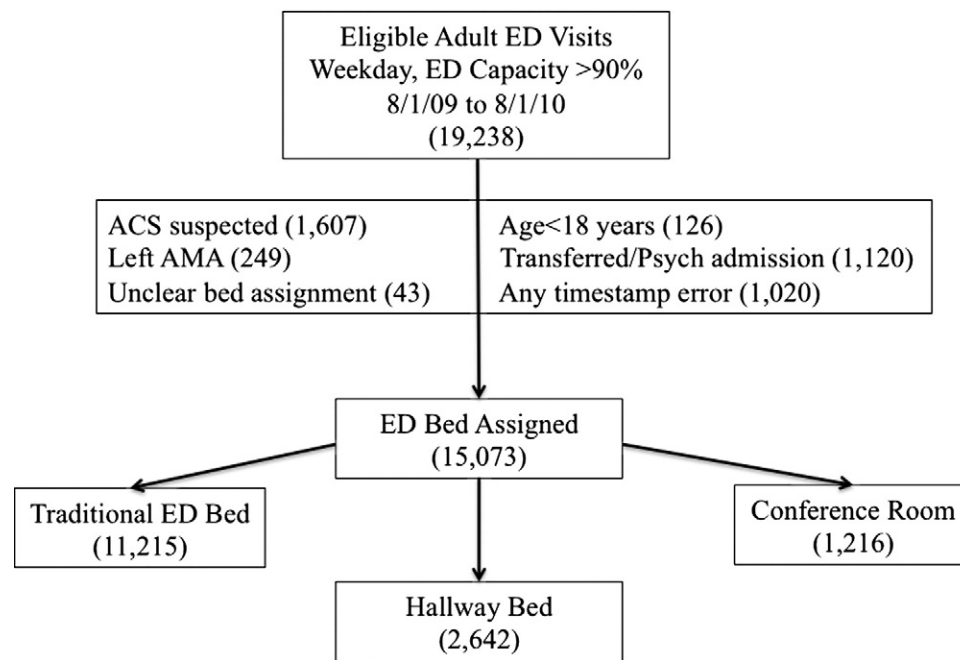


Fig. 1 Inclusion criteria.

The 7 hallway beds were located in separate hallways adjacent to traditional rooms. The 5 conference room beds were physically separated from the rest of the ED in an area originally designed to be the department's conference room. Hallway and conference room beds supplies were obtained from adjacent treatment rooms or from the department supply room.

The primary outcome was *ED evaluation time*, defined as the time between ED bed assignment and ED disposition (admission or discharge). ED bed assignments and hospital bed requests were performed electronically and were marked with electronic time stamps. Hospital bed requests were placed electronically after discussion with an accepting physician and were placed either by the resident or attending physician caring for the patient; the process of electronically denoting admission status with request for an inpatient bed is performed in real time in the ED and is separate from admission orders by admitting physician. The discharge time stamp indicated the time at which the treating ED physician activated an electronic alert to communicate to the ED nurse that discharge a paperwork was complete.

Secondary analyses included evaluating the relationship between bed assignment and ED evaluation time stratified by the 5 most frequent chief complaint categories. During the triage process, chief complaints were assigned an *International Statistical Classification of Diseases and Related Health Problems* code. Based on discussions with the physicians assigned to the triage area, these codes were grouped into complaints by body system (Appendix 1) to maximize clinical importance.

The local institutional review board approved this study after expedited review.

2.1. Sample size and power calculations

Using prior data published from our institution [27], we estimated the mean ED total length of stay to be approximately 240 minutes, with a standard deviation of 100 minutes. With an α of .05 and power of 0.8, and assuming a 10:1 ratio of traditional beds to conference room beds, 550 conference room patient encounters would be necessary to detect a 1-minute difference in ED evaluation time. We expected that more patients would be assigned to hallway beds than to conference room beds.

2.2. Analysis

Analyses included simple and multivariate linear regression to evaluate the relationship between bed type (traditional, hallway, conference room) and ED evaluation time. Because ED evaluation times were highly right skewed, we performed natural log transformation of these data. In a multivariate model, we adjusted for multiple ED-level and patient-level characteristics (Appendix 2), including measures of patient acuity and ED crowding. All patient and ED characteristics were electronically recorded at the time of patient check-in, before bed assignment.

Using the back-transformed data obtained from multiple linear regression, marginal prediction was used to calculate the mean ED evaluation time for each bed type [28,29]. Marginal prediction was used because unlike direct adjustment, it allows for comparison across strata, giving an internally adjusted measure. Differences in mean ED evaluation times were calculated using the mean ED evaluation time for traditional beds as the referent. Bootstrapping with 1000 repetitions was used to compute 95%

Table 1 Patient and ED characteristics

	Traditional bed (11 215)	Hallway bed (2642)	Conference room bed (1216)
Age (y) ^a	44 (29, 60)	39 (28, 52)	41 (28, 55)
Sex, female (%)	55	57	62
Insurance (%)			
Private	34	38	38
State/Federal	48	43	43
Self-pay	15	16	17
Mode of arrival (%)			
Ambulance	25	13	7
Car	70	85	93
Helicopter	4	2	0
ESI ^a	2 (2, 3)	3 (2, 3)	3 (2, 3)
Disposition (%)			
Discharged	58	76	77
Admitted	42	24	23
Waiting room time (min) ^a	44 (20, 74)	39 (17, 90)	32 (17, 55)
ED evaluation time (min) ^a	227 (146, 329)	234 (159, 333)	236 (162, 344)
Boarding time (min) ^a	239 (95, 780)	422 (162, 1126)	283 (151, 928)

ESI indicates emergency severity index; min indicates minutes.

^a Median (interquartile range).

confidence intervals (CIs) [30]. These analyses were repeated separately for each chief complaint category. All analyses were done using Stata/IC 11.2 (Copyright © 2009; Stata, College Station, TX).

3. Results

During the 1-year study period, 19 239 patient visits met the inclusion criteria; that is, the visit occurred when the ED was functioning above 90% capacity on a weekday, disposition was determined after bed assignment, and the first physician orders were placed after ED bed assignment. After exclusion criteria, 15 073 patient visits remained (Fig. 1).

Table 2 Mean ED evaluation time, in minutes

	Mean time (min) (95% Confidence Interval) ^a
Unadjusted linear regression	
Traditional bed	209 (207-212)
Hallway bed	225 (219-231)
Conference room bed	226 (218-235)
Adjusted linear regression ^b	
Traditional bed	227 (226-228)
Hallway bed	240 (240-241)
Conference room bed	238 (237-239)

^a Mean (95% CI); all $P < .001$.^b Adjusted for ED and patient level characteristics listed in Appendix 2.**Table 3** Adjusted mean ED evaluation time, by chief complaint

Chief complaints	Traditional (95% CI) ^a	Hallway (95% CI) ^a	Conference room (95% CI) ^a
Abdominal	249 (247-250)	265 (263-266)	258 (256-259)
Joint	196 (194-197)	208 (207-211)	210 (208-212)
Fever, general	230 (228-232)	233 (232-235)	237 (235-239)
Head, neck	211 (209-214)	239 (236-241)	222 (219-224)

^a Adjusted mean time in minutes (95% CI); all $P < .001$; adjusted for the variables listed in Appendix 2.

Patient and ED demographics are presented in Table 1. Demographics were similar across bed types, with the exceptions of sex, disposition, and mode of arrival. No patients who met inclusion criteria died while in the ED.

After log transformation of ED evaluation time, we confirmed that the models met the necessary assumptions to perform linear regression. Linear regression results comparing mean ED evaluation times by bed type are presented in Tables 2 and 3. The differences in the mean ED evaluation times for bed types, with traditional beds as the referent group, are presented in Table 4.

Adjusted analysis revealed that hallway beds were associated with an increase in a mean ED evaluation time of 13.3 minutes (95% CI, 13.2-13.3; $P < .001$) compared with patients assigned to traditional beds, whereas conference room beds were associated with an increase in a mean ED evaluation time of 10.9 minutes (95% CI, 10.8-10.9; $P < .001$).

The relationship between bed type and ED evaluation time varied by chief complaint. Assignment to hallway beds was associated with longer delays for patients with abdominal/genitourinary and head/neck complaints compared with patients with the same complaints in conference room beds; hallway and conference room beds were associated with similar delays for patients with joint complaints and for patients with generalized complaints such as fever.

4. Discussion

Demand for care in the ED varies widely but predictably by time of day, day of week, and season. Adequately meeting

Table 4 Differences in adjusted mean ED evaluation time^a

Chief complaints	Hallway (95% CI) ^b	Conference room (95% CI) ^b
All complaints	13.3 (13.2-13.3)	10.9 (10.8-10.9)
Abdominal	16.0 (15.9-16.1)	9.0 (9.0-9.1)
Joint	13.2 (13.1-13.3)	14.5 (14.3-14.6)
Fever, general	3.5 (3.4-3.5)	7.5 (7.4-7.6)
Head, neck	27.4 (27.1-27.7)	10.2 (10.0-10.3)

^a Traditional bed referent.^b Difference in adjusted mean time in minutes (95% CI).

patient needs requires flexibility in staffing and resource utilization. Previous work suggests that simply increasing the number of traditional beds may not be an adequate solution for ED crowding [27]. Particularly in the current health care climate of cost containment, exclusively focusing on expanding ED physical space is unlikely to be an acceptable sole solution. Use of nontraditional patient care areas such as hallways and conference rooms may offer benefit to alleviated ED crowding, but these approaches have not been well studied.

To our knowledge, this is the first study evaluating the relationship between nontraditional ED beds and the duration of ED evaluations. After adjusting for multiple ED and patient characteristics, the mean ED evaluation times were approximately 11 and 13 minutes longer for patients assigned to hallway and conference room beds, respectively, compared with patients assigned to traditional ED beds. Of the patients who presented to our ED, 13% were assigned to hallway beds and 5% were assigned to conference room beds. Therefore, over the course of each day, patients assigned to nontraditional beds accrued approximately 325 more minutes in an ED bed than if they been assigned a traditional bed. Based on the typical ED evaluation time in our department, an additional 1.25 patients could have been evaluated per day had the patients in nontraditional beds had the same evaluation time as patients in traditional beds. The small increases in evaluation time for patients in nontraditional beds suggest that, from an ED throughput perspective, using these beds may be preferable to keeping patients in the waiting room until a traditional bed is available.

Several factors may contribute to patients in nontraditional beds having longer ED evaluation times compared with patients in traditional beds. Treating physicians and nurses may consciously or subconsciously presume that patients in nontraditional beds are “less sick” than their counterparts assigned to traditional beds, despite the fact that the priority of the triage physician or nurse is to move patients from the waiting room to a treatment area, regardless of bed type. In addition, medical supplies may not be readily available at the bedside, and private discussions and sensitive examinations are difficult to do well in nontraditional bed settings.

Previous research has indicated that boarding of admitted patients in the ED is one of the main contributors to ED crowding [2,4,7,31]. Thus, ED boarding is a strong driver in the pressure to use nontraditional beds. In our study, the number of patients in the ED waiting room rarely outnumbered the number of patients boarded in the ED (<14% of the time); thus, nontraditional ED beds can be viewed as a workaround or a “pop off valve” to compensate for inadequate access to inpatient beds. It is possible that addressing the underlying causes of ED boarding such as variability in planned admissions and elective surgeries [32–34] may obviate the need for the use of nontraditional beds.

Factors other than throughput time are important when deciding whether to use nontraditional beds. Beds located in hallways and conference room lack privacy and are not conducive to procedures, sensitive conversations [35], or invasive examinations, particularly rectal and genitourinary examinations [17]. Patients with comorbidities such as dementia and psychosis may be at higher risk for falls if placed in hallway and conference room beds, where they are more likely to be exposed to a loud, chaotic environment [36]. These aspects of nontraditional bed use were not evaluated in this study and will be important topics for future research.

Our findings suggest that patients assigned to nontraditional beds experience a small delay in ED disposition compared with traditional beds. Patients with certain complaints such as musculoskeletal pain and joint problem appear to experience shorter delays in nontraditional beds than patients who are likely to require private examinations, such as those with abdominal and genitourinary complaints, or invasive procedures such as lumbar puncture. Targeting a subset of patients, that is, those who are less likely to require private examinations or invasive procedures, for assignment to nontraditional beds may be an efficient strategy for optimizing the use of nontraditional beds, although this approach may lead to further delays in evaluation for patients with complaints such as abdominal pain if these patients must wait for specific ED beds to become available. Further research is needed to characterize institutional and departmental variables that influence the usability of nontraditional ED beds and to determine how best to use nontraditional beds to maximize the quality of patient care.

4.1. Limitations

This was an observational study using administrative data and, therefore, is limited by lack of randomization and unmeasured confounders. We attempted to minimize unmeasured confounders by focusing the analysis on similar patients groups, for example, by including only patient visits occurring when nontraditional beds were available and including only patients who were not evaluated, discharged, or admitted from the waiting room. In addition, we adjusted for multiple patient-level and department-level factors, for example, by limiting the analysis to times when the ED was functioning above 90% capacity and including ED capacity as a variable in the adjusted analysis.

As with any study performed at a single institution, the results of this study may not be generalizable to all other hospitals. For example, rather than use a fast-track, the study hospital assigned a physician to the triage area who treated and discharged approximately 1 patient per hour from the waiting room. In addition, patients at the study hospital moved from nontraditional beds into traditional beds under certain conditions, but patients in traditional beds did not move into nontraditional beds. Therefore, any unintentional

preference in bed assignment would likely have been to assign nontraditional beds for patients expected to have shorter evaluation times or to be discharged, biasing toward the null hypothesis. Thus, our findings may underestimate the true difference in ED evaluation times among ED bed types.

Patient visits with time stamp errors were excluded; however, it is unlikely that time stamp errors occurred in a pattern related to either bed assignment or ED evaluation time.

Lastly, the prevalence and practice of nontraditional beds use have not been reported in the medical literature in detail. Nursing and physician staffing patterns, the physical layout of an ED, and the ability to conduct private interviews and examinations in nontraditional beds may vary across EDs and influence the efficiency and effectiveness of their use.

5. Conclusion

In this retrospective, observational single-center study, patients assigned to hallway or conference room beds experienced modestly longer ED evaluation times, 11 and 13 minutes respectively, compared with patients assigned to traditional ED beds. Patients with general complaints such as fever who were assigned to nontraditional beds had the smallest increases in ED evaluation time, suggesting that selective use of nontraditional beds for patients with specific complaints may be an efficient strategy to improve ED flow during periods of ED crowding.

Appendix 1. Most frequent chief complaints, categorized by ICD-9

Chief complaint	ICD-9	Traditional Hallway (11 215)	Conference room (2642)	room (1216)
Abdominal, genitourinary	536.42-578.1, 599.1-643.9, 787.01-789.09	2291 (20%)	536 (20%)	289 (24%)
Joint and muscle complaints	719.41-729.89	1191 (11%)	547 (21%)	266 (22%)
General complaints (fever, malaise)	780.6-783.21	1268 (11%)	307 (12%)	183 (15%)
Head and neck	368.16-389.9, 462-528.9, 784, 784.4, 784.7	1189 (11%)	374 (14%)	183 (15%)
Other		5276 (47%)	878 (33%)	295 (24%)
Total		11 215	2642	1,216

ICD-9 indicates *International Statistical Classification of Diseases and Related Health Problems*.

Appendix 2. Model covariates, measured at the time of check-in

ED-level factors	Occupancy rate (proportion of ED beds occupied) Total no. of patients in the ED Mean ESI of all patients in the ED No. of boarding patients Average boarding time No. of patients in the waiting room Average length of stay in the waiting room
Patient-level factors	Mode of arrival (car, ambulance, helicopter) Age in years Sex ESI Time of day (day, evening, overnight) Category of chief complaint (Appendix 1) Vital signs HR: <60, 60-100, 101-140, >140 SBP: <80, 80-100, 101-150, 150-200, >200 O ₂ sat: <88%, >88% RR: <12, 12-20, >20

ESI indicates emergency severity index [30]; HR, heart rate in beats per minute; SBP, systolic blood pressure in millimeters of mercury; O₂ sat, oxygen saturation in percent; RR, respiratory rate in breaths per minute.

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